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US 4110685 A

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INT CL[6] **G01R 27/06 27/28**
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(54) Abstract Title

Method of measuring a standing wave ratio in a mobile communication system

(57) A method of measuring a standing wave ratio comprises providing a signal to an antenna, measuring the strength of the resulting forward and reflected signals and calculating the standing wave ratio from the strength of the said forward and reflected signals. The standing wave ratio may be calculated from the difference between the strength of the forward and reflected signals. Alternatively a variable attenuator 290 may be adjusted to attain a prescribed relationship between the forward and reflected signals and the required attenuation value is then used to calculate the standing wave ratio. These methods may be employed to test the operation of a mobile communication system base station and its associated antennas for operation in transmission and reception modes. The method may involve the generation or transmission of a test signal by or via a portable radio telephone.

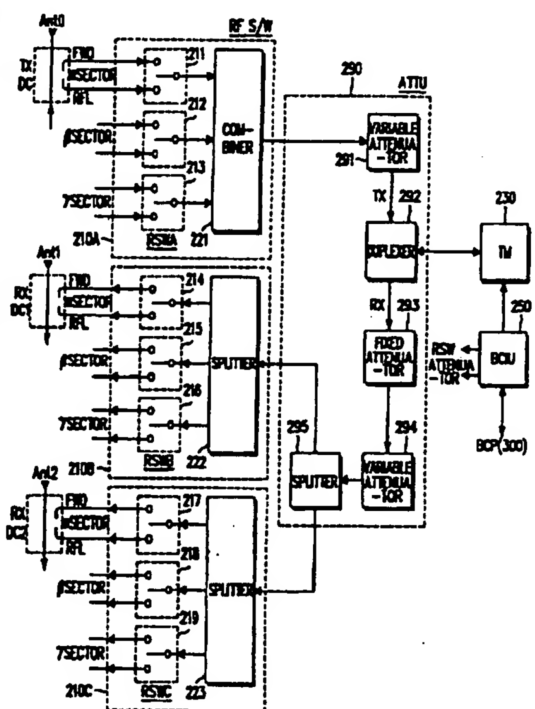

FIG. 3

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

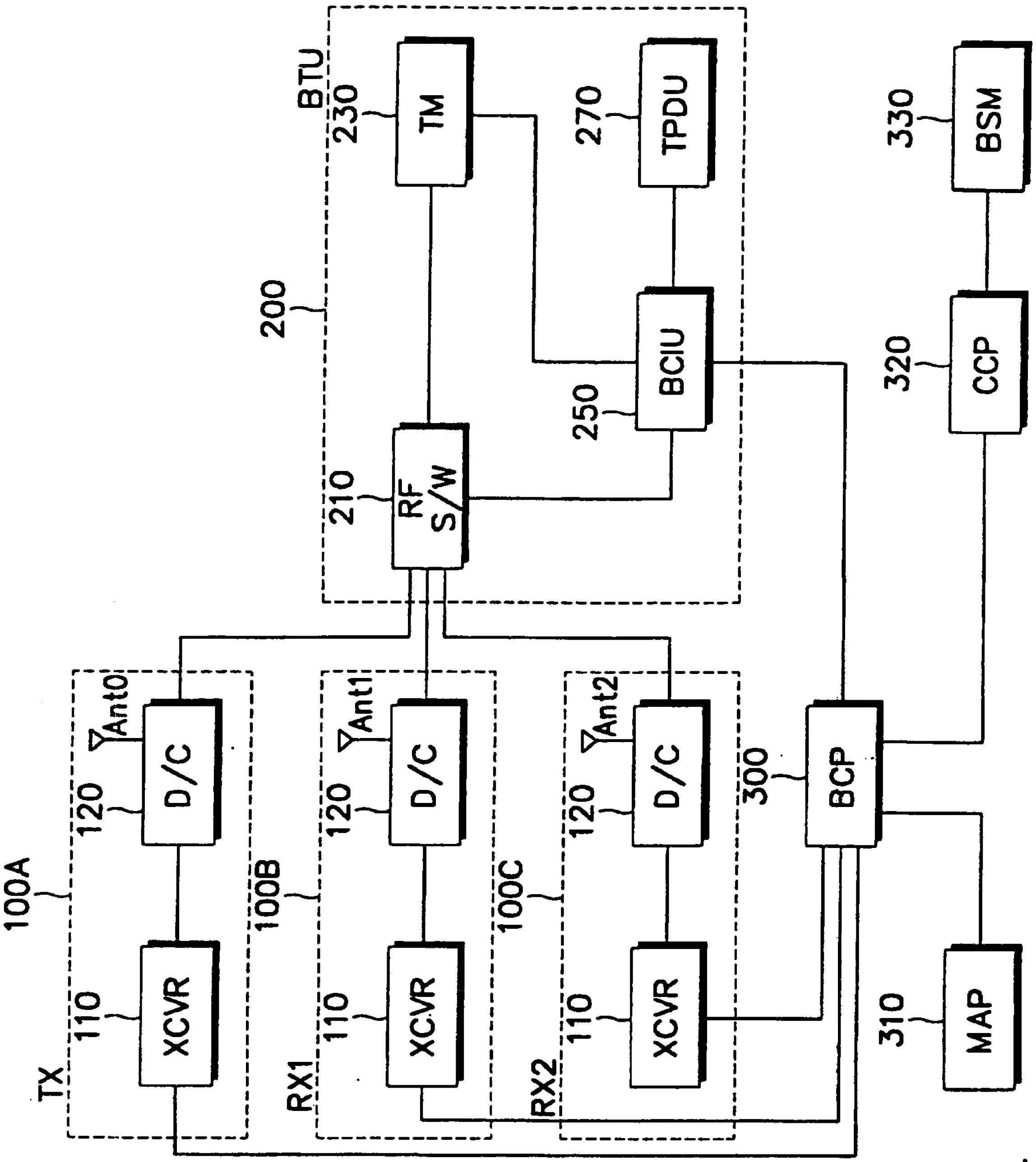
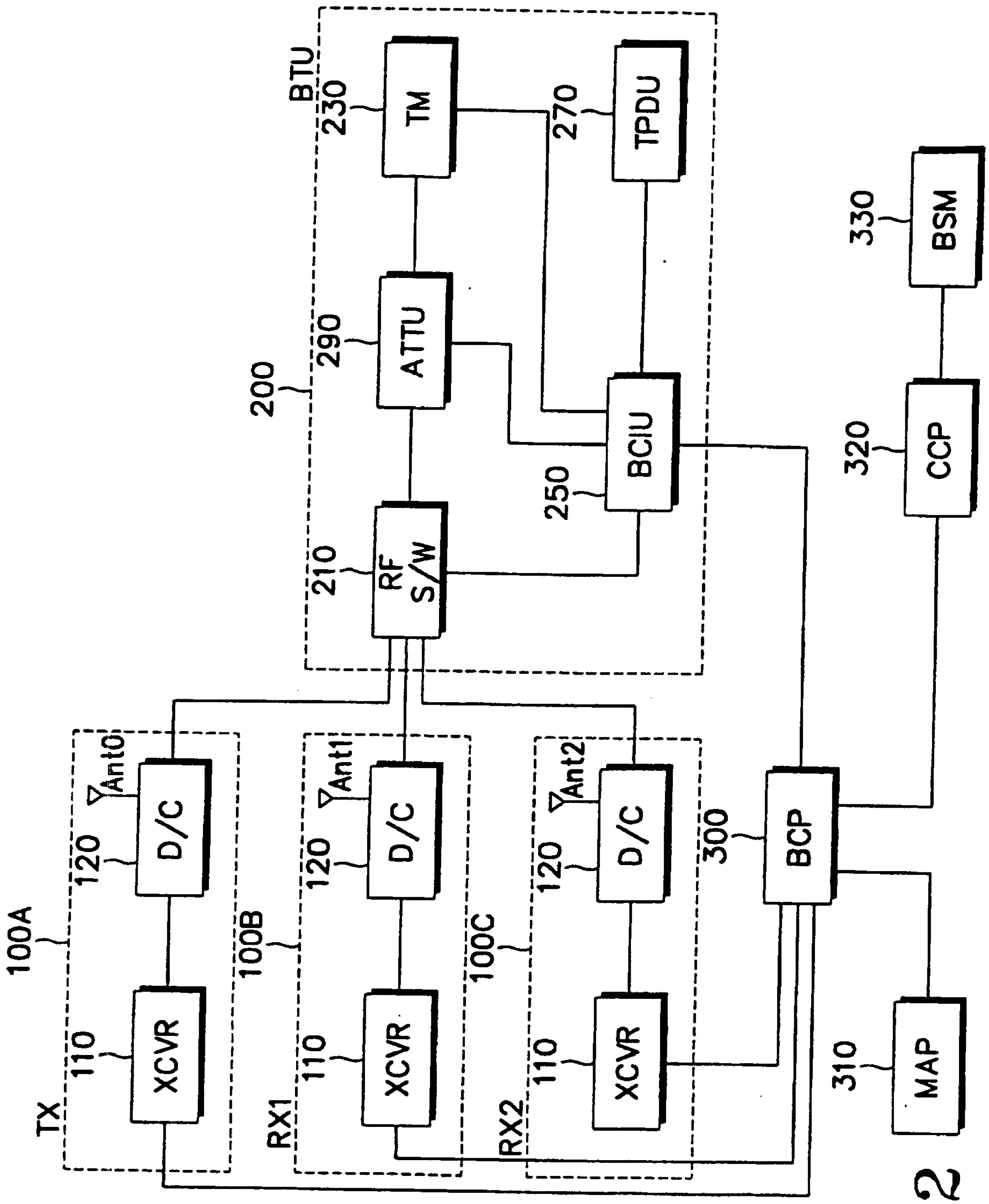

100A
TX
110
XCVR
120
D/C
Ant0
100B
RX1
110
XCVR
120
D/C
Ant1
100C
RX2
110
XCVR
120
D/C
Ant2
200
BTU
210
RF S/W
230
TM
250
BCIU
270
TPDU
300
BCP
310
MAP
320
CCP
330
BSM

FIG. 1



BTU
230
TM
270
TPDU
200
290
ATTU
250
BCIU
210
RF S/W
330
BSM
320
CCP
100A
TX
110
XCVR
120
D/C
Ant0
100B
RX1
110
XCVR
120
D/C
Ant1
100C
RX2
110
XCVR
120
D/C
Ant2
300
BCP
310
MAP

FIG. 2

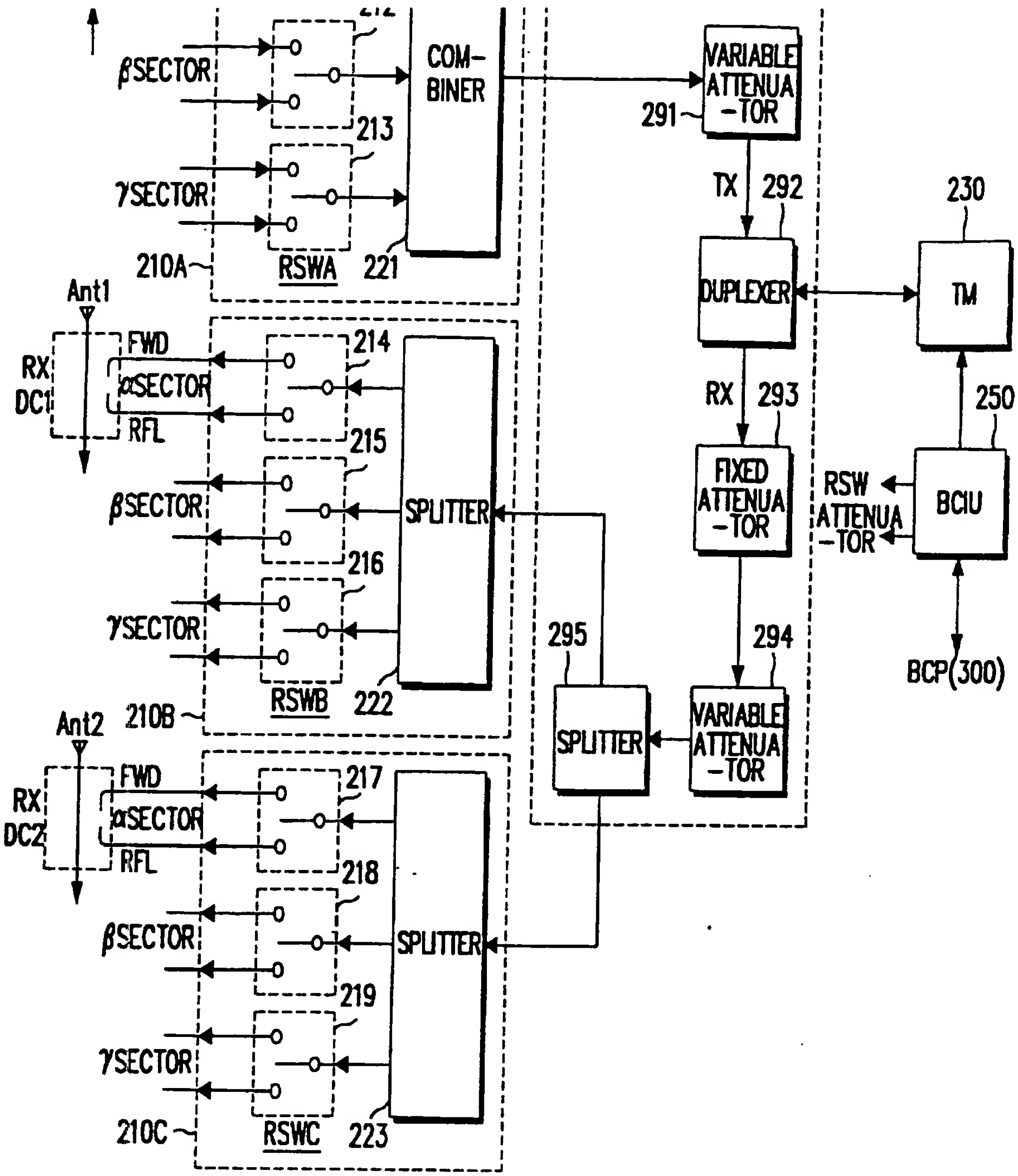

βSECTOR
γSECTOR
210A
RSWA
221
213
COM-
BINER
VARIABLE
ATTENUA
-TOR
291
TX
292
DUPLEXER
TM
230
RX
293
FIXED
ATTENUA
-TOR
250
RSW
ATTENUA
-TOR
BCIU
BCP(300)
294
VARIABLE
ATTENUA
-TOR
295
SPLITTER
Ant1
RX
DC1
FWD
αSECTOR
RFL
214
215
216
βSECTOR
γSECTOR
SPLITTER
RSWB
222
210B
Ant2
RX
DC2
FWD
αSECTOR
RFL
217
218
219
βSECTOR
γSECTOR
SPLITTER
RSWC
223
210C

FIG. 3

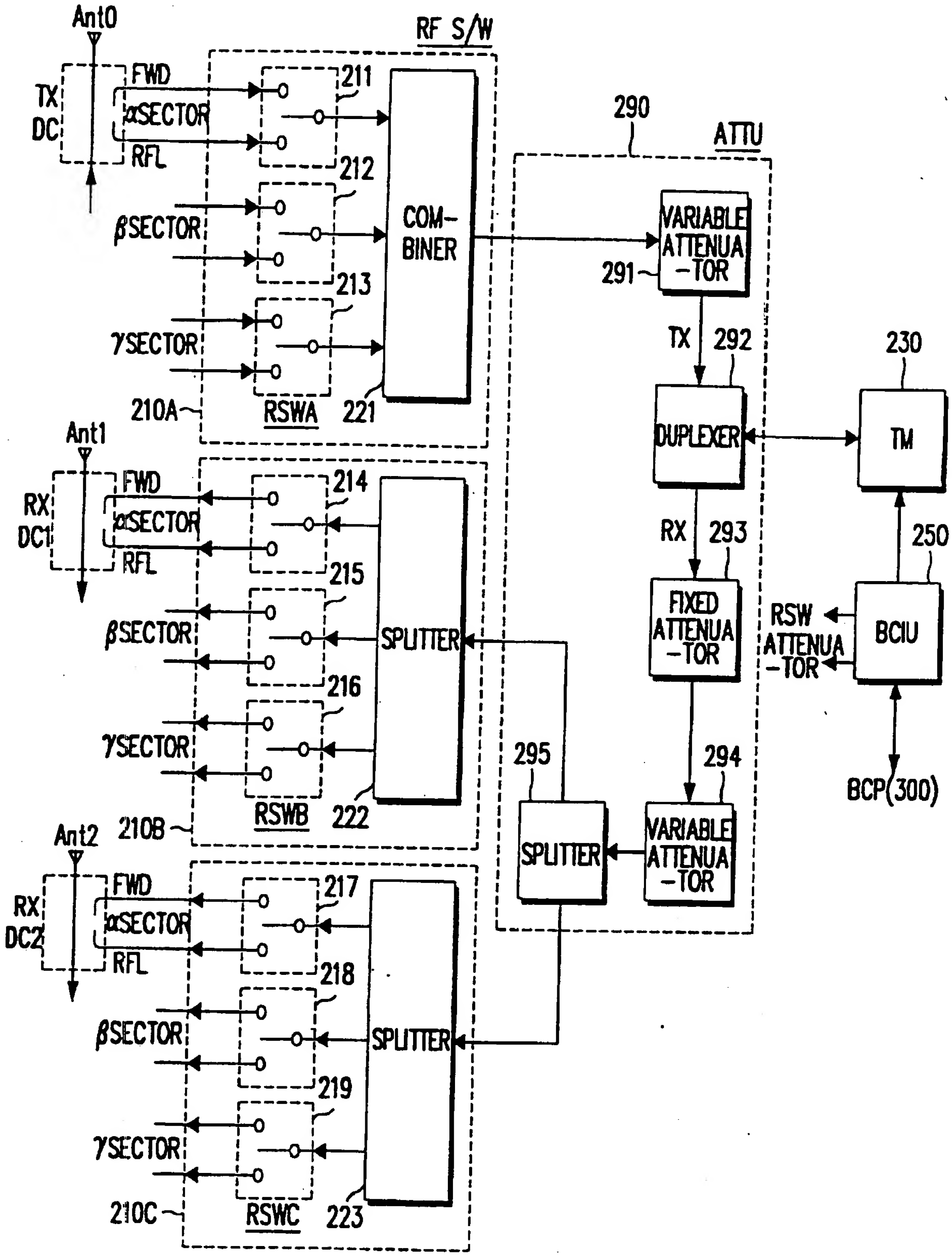

RF S/W
Ant0
TX DC
FWD
αSECTOR
RFL
βSECTOR
γSECTOR
211
212
213
COM-BINER
210A
RSWA
221
290
ATTU
VARIABLE ATTENUA-TOR
291
TX
292
DUPLEXER
RX
293
FIXED ATTENUA-TOR
294
VARIABLE ATTENUA-TOR
295
SPLITTER
230
TM
250
BCIU
RSW ATTENUA-TOR
BCP(300)
Ant1
RX DC1
214
215
216
SPLITTER
210B
RSWB
222
Ant2
RX DC2
217
218
219
SPLITTER
210C
RSWC
223

FIG. 3

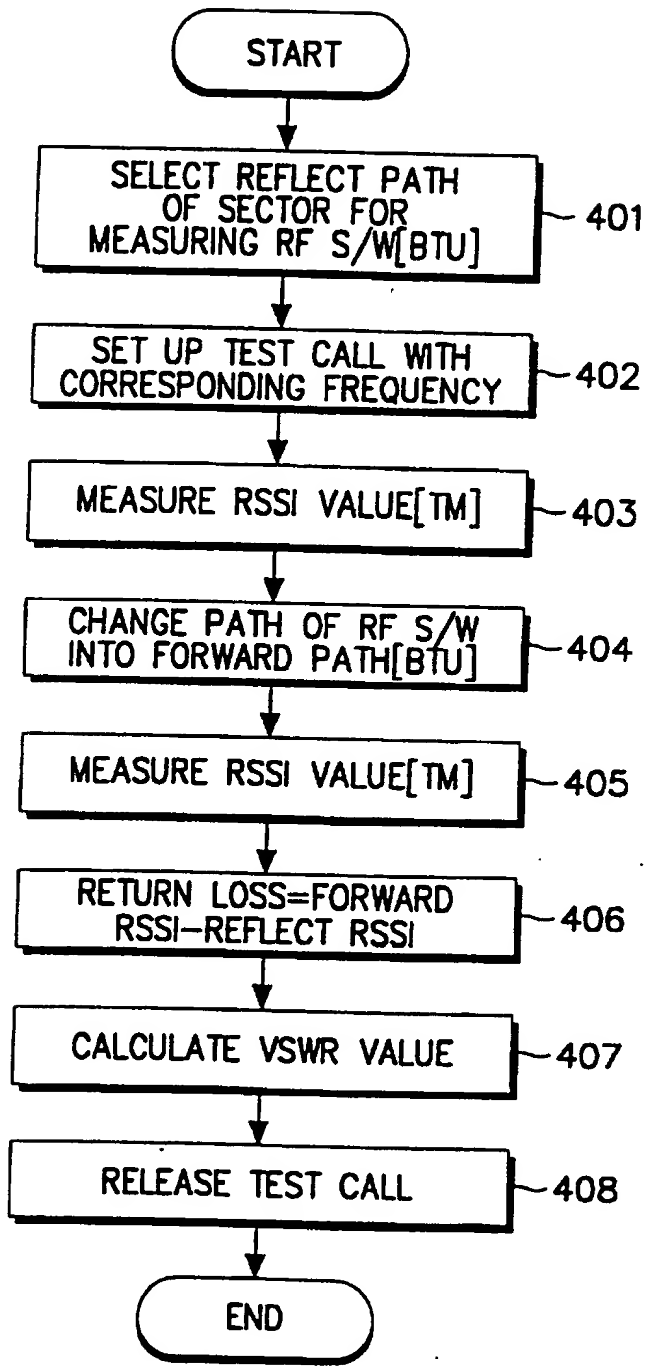

START
SELECT REFLECT PATH OF SECTOR FOR MEASURING RF S/W[BTU]
401
SET UP TEST CALL WITH CORRESPONDING FREQUENCY
402
MEASURE RSSI VALUE[TM]
403
CHANGE PATH OF RF S/W INTO FORWARD PATH[BTU]
404
MEASURE RSSI VALUE[TM]
405
RETURN LOSS=FORWARD RSSI-REFLECT RSSI
406
CALCULATE VSWR VALUE
407
RELEASE TEST CALL
408
END

FIG. 4

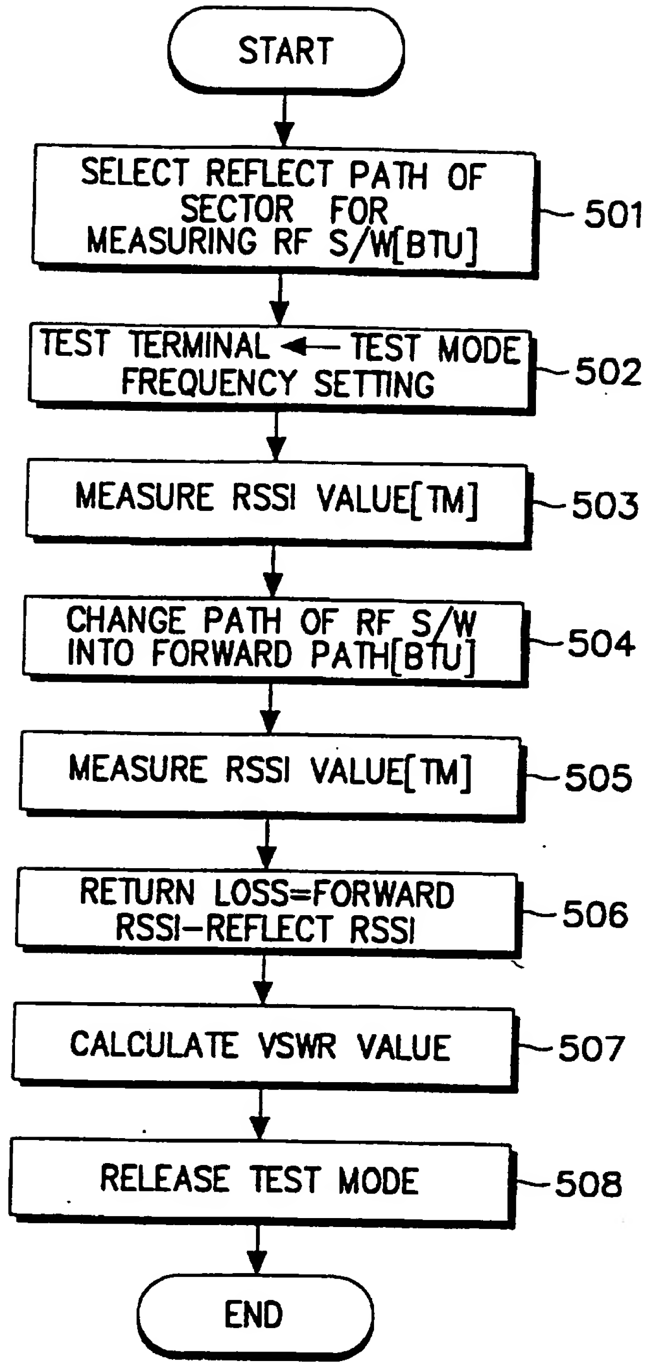

START
SELECT REFLECT PATH OF SECTOR FOR MEASURING RF S/W[BTU]
501
TEST TERMINAL ◄— TEST MODE FREQUENCY SETTING
502
MEASURE RSSI VALUE[TM]
503
CHANGE PATH OF RF S/W INTO FORWARD PATH[BTU]
504
MEASURE RSSI VALUE[TM]
505
RETURN LOSS=FORWARD RSSI-REFLECT RSSI
506
CALCULATE VSWR VALUE
507
RELEASE TEST MODE
508
END

FIG. 5

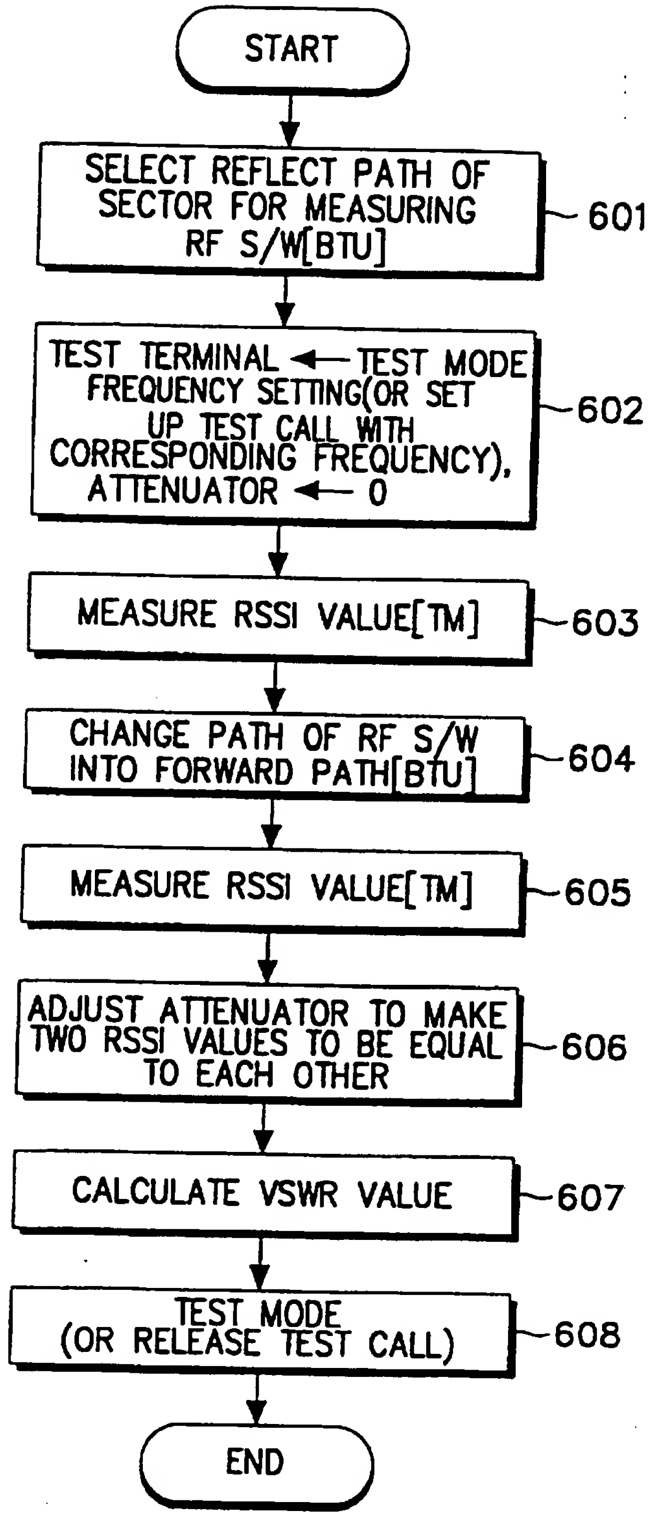

START
SELECT REFLECT PATH OF SECTOR FOR MEASURING RF S/W[BTU]
601
TEST TERMINAL ← TEST MODE FREQUENCY SETTING(OR SET UP TEST CALL WITH CORRESPONDING FREQUENCY), ATTENUATOR ← 0
602
MEASURE RSSI VALUE[TM]
603
CHANGE PATH OF RF S/W INTO FORWARD PATH[BTU]
604
MEASURE RSSI VALUE[TM]
605
ADJUST ATTENUATOR TO MAKE TWO RSSI VALUES TO BE EQUAL TO EACH OTHER
606
CALCULATE VSWR VALUE
607
TEST MODE (OR RELEASE TEST CALL)
608
END

FIG. 6

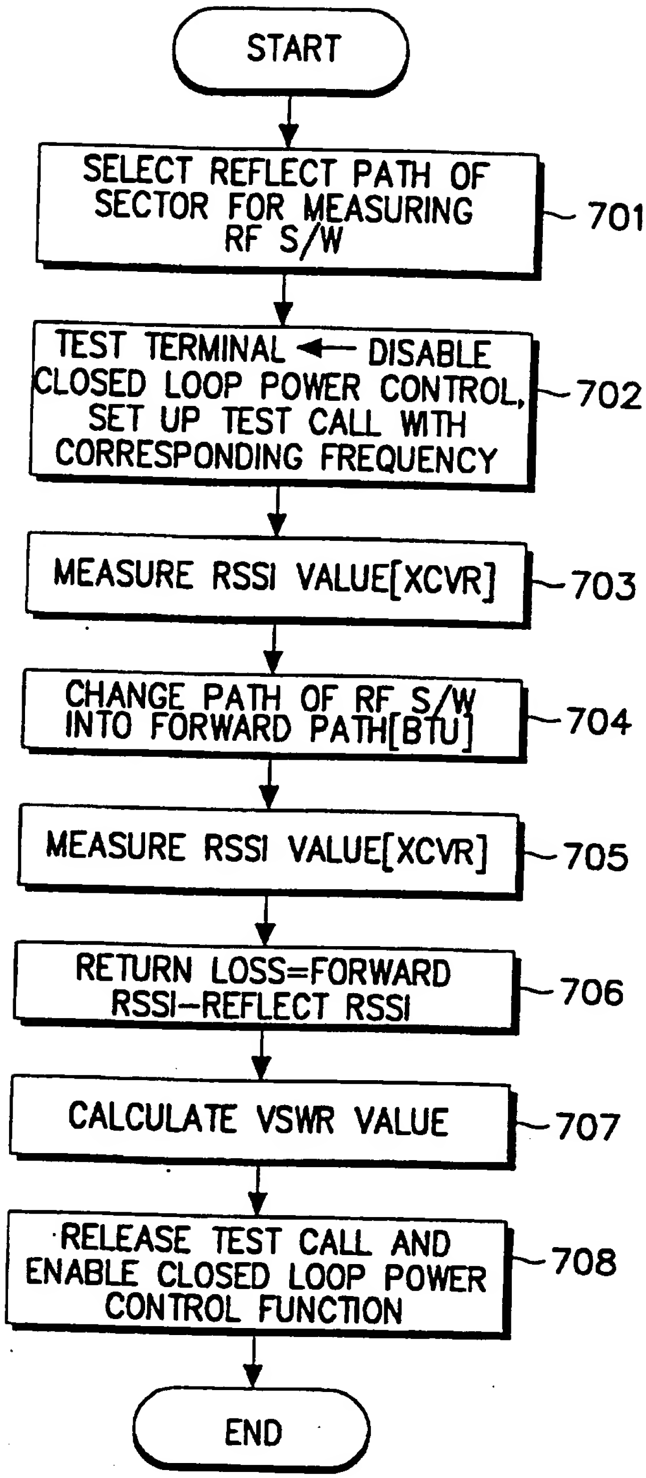

START
SELECT REFLECT PATH OF SECTOR FOR MEASURING RF S/W
701
TEST TERMINAL ← DISABLE CLOSED LOOP POWER CONTROL, SET UP TEST CALL WITH CORRESPONDING FREQUENCY
702
MEASURE RSSI VALUE[XCVR]
703
CHANGE PATH OF RF S/W INTO FORWARD PATH[BTU]
704
MEASURE RSSI VALUE[XCVR]
705
RETURN LOSS=FORWARD RSSI-REFLECT RSSI
706
CALCULATE VSWR VALUE
707
RELEASE TEST CALL AND ENABLE CLOSED LOOP POWER CONTROL FUNCTION
708
END

FIG. 7

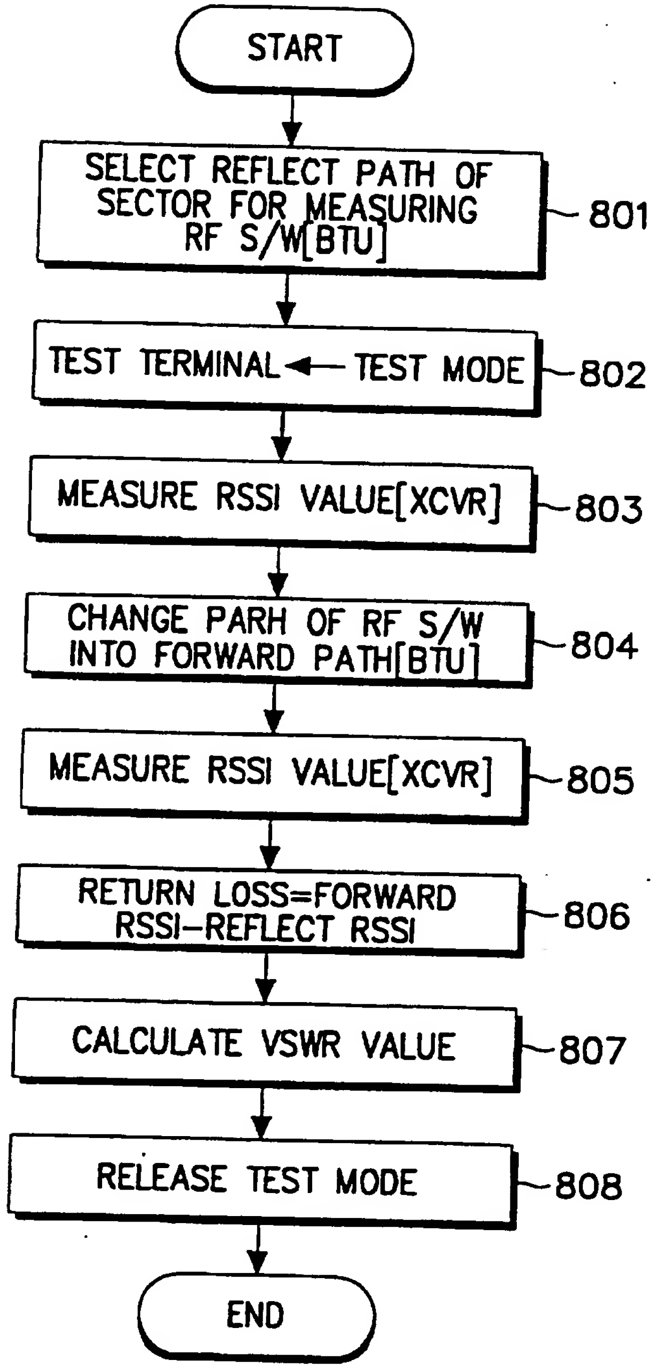

START
SELECT REFLECT PATH OF SECTOR FOR MEASURING RF S/W[BTU]
801
TEST TERMINAL ← TEST MODE
802
MEASURE RSSI VALUE[XCVR]
803
CHANGE PARH OF RF S/W INTO FORWARD PATH[BTU]
804
MEASURE RSSI VALUE[XCVR]
805
RETURN LOSS=FORWARD RSSI–REFLECT RSSI
806
CALCULATE VSWR VALUE
807
RELEASE TEST MODE
808
END

FIG. 8

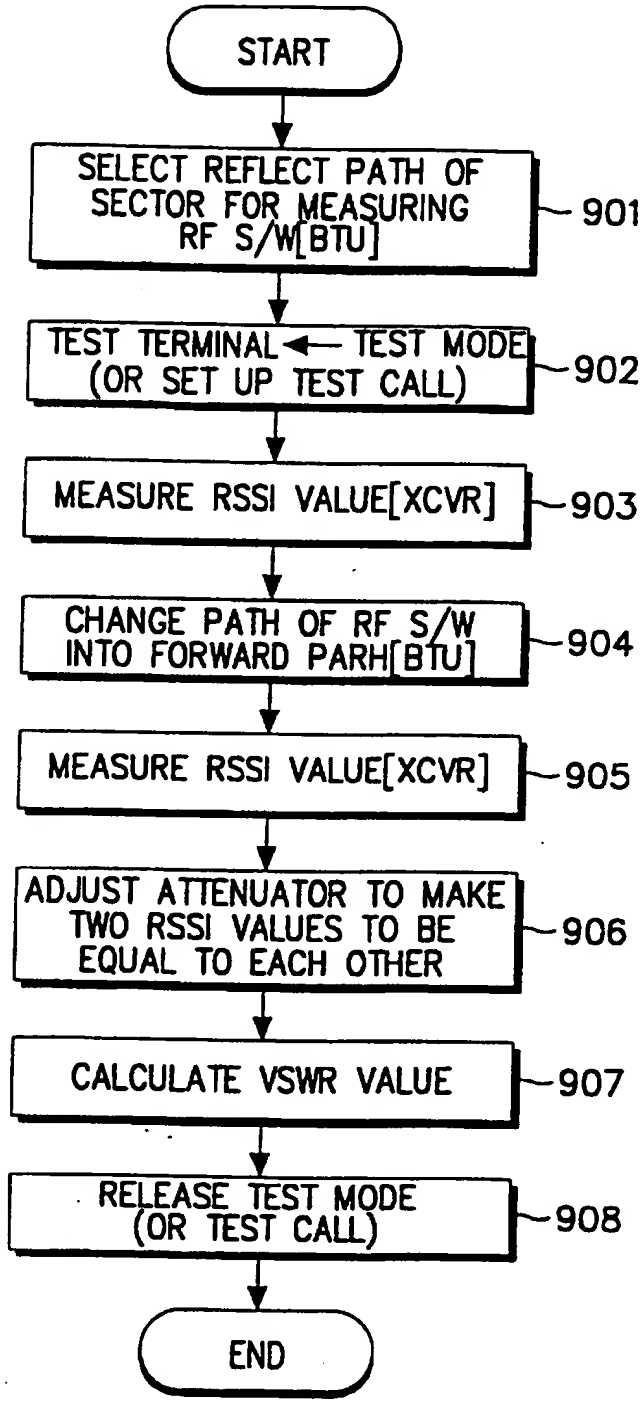

START
SELECT REFLECT PATH OF SECTOR FOR MEASURING RF S/W[BTU]
901
TEST TERMINAL ← TEST MODE (OR SET UP TEST CALL)
902
MEASURE RSSI VALUE[XCVR]
903
CHANGE PATH OF RF S/W INTO FORWARD PARH[BTU]
904
MEASURE RSSI VALUE[XCVR]
905
ADJUST ATTENUATOR TO MAKE TWO RSSI VALUES TO BE EQUAL TO EACH OTHER
906
CALCULATE VSWR VALUE
907
RELEASE TEST MODE (OR TEST CALL)
908
END

FIG. 9

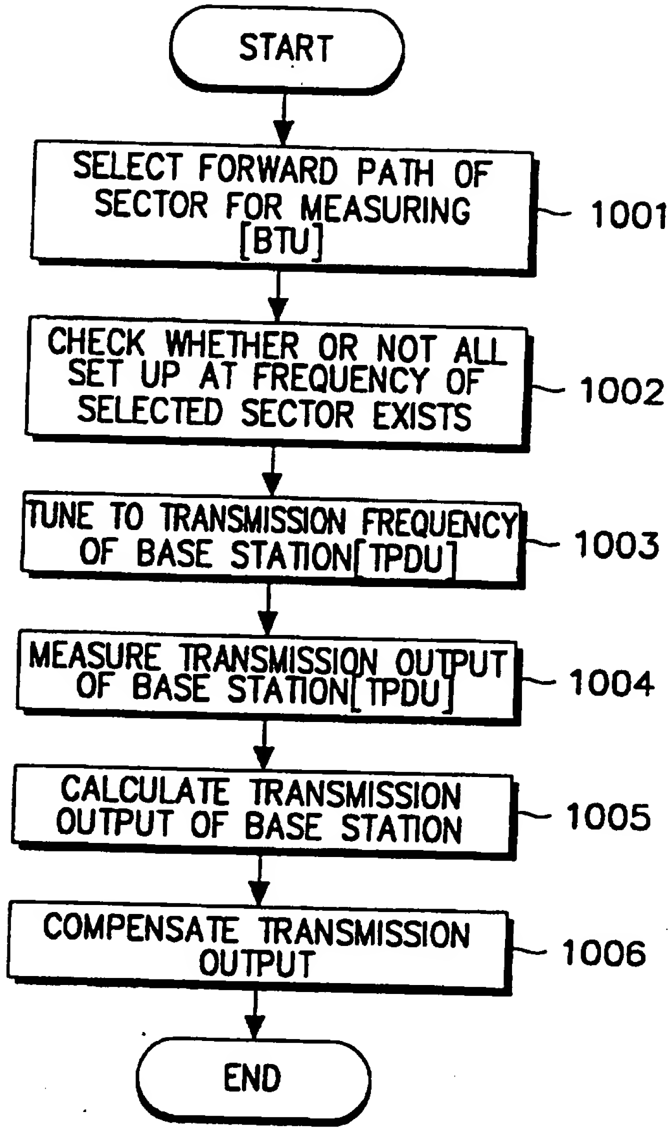

START
SELECT FORWARD PATH OF SECTOR FOR MEASURING [BTU]
1001
CHECK WHETHER OR NOT ALL SET UP AT FREQUENCY OF SELECTED SECTOR EXISTS
1002
TUNE TO TRANSMISSION FREQUENCY OF BASE STATION[TPDU]
1003
MEASURE TRANSMISSION OUTPUT OF BASE STATION[TPDU]
1004
CALCULATE TRANSMISSION OUTPUT OF BASE STATION
1005
COMPENSATE TRANSMISSION OUTPUT
1006
END

FIG. 10

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METHOD OF MEASURING STANDING WAVE RATIO IN MOBILE COMMUNICATION SYSTEM

BACKGROUND TO THE INVENTION

The present invention relates to base station testing in a mobile communication system.

In general, a mobile communication system such as a code division multiple access ("CDMA") system is constructed with a plurality of base stations, a mobile station and a BSM (base station manager). The base stations are in radio communication with the mobile station, so as to enable each of the base stations to communicate with a PSTN (public switched telephone network). To allow smooth communication of the base stations with the PSTN, it is necessary to check periodically and diagnose whether or not any abnormal conditions exist at the base station or the base station is out of order. Thus, a base station test unit for testing the base station having the ability to monitor and diagnose the existence/nonexistence of and faults in the base station is required.

Such a base station test unit can be used in a number of test functions of the base stations. In particular, if the radio unit of the base station with an external antenna is damaged, the test unit can usefully be utilized in testing whether or not there is damage to the antenna or whether or not there is damage in the radio unit of the base station. A characteristic value of the system which is representative of and used to indicate the existence/nonexistence of the radio unit of the base station and damage to the base station is a voltage standing wave ratio ("VSWR"). Therefore, the radio unit of the base station can be tested by measuring the VSWR.

However, there is a limit to measurement of the VSWR since it requires the necessary hardware for measuring the VSWR and a controller capable of controlling the hardware to be

separately installed.

SUMMARY OF THE INVENTION

It is an objective of the present invention to provide an improved method for measuring VSWR.

Accordingly, the present invention provides a method of measuring a standing wave ratio for an antenna in a base station of a mobile communication system comprising:

transmitting a test signal to the antenna;

during transmission of the test signal, measuring the strength of a forward signal and the strength of a reflect signal for the antenna; and

calculating the standing wave ratio for the antenna from the measured strength of the forward signal and the measured strength of the reflect signal.

Preferably, the standing wave ratio is calculated from the difference between the strength of the forward signal and the strength of the reflect signal.

The present invention also provides a method of measuring a standing wave ratio for an antenna in a base station of a mobile communication system comprising:

transmitting a test signal to the antenna;

during transmission of the test signal, adjusting the attenuation value of a variable attenuator so as to cause the strength of a forward signal and the strength of a reflect signal for the antenna to take on a predetermined relationship; and

calculating the standing wave ratio for the antenna from the adjusted attenuation value.

Preferably, the predetermined relationship is equality.

The antenna may be a transmission antenna or a reception antenna.

The test signal may be generated by a test terminal

included within the base station. For example, the test signal may be generated by relaying an external test call received by the test terminal, in response to a requirement for measurement of the standing wave ratio. Alternatively, the test signal may be originated by the test terminal, which enters a test mode in response to a requirement for measurement of the standing wave ratio.

Preferably, a closed loop power control function of the test terminal is disabled.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described by way of example with reference to the accompanying drawings in which:

FIGs. 1 and 2 are block diagrams of a CDMA base station to which the present invention may be applied;

FIG. 3 is a block diagram of a base station test unit for testing the base station as illustrated in FIGs. 1 and 2;

FIG. 4 is a flow chart showing the process of measuring a standing wave ratio of a transmission antenna using a test call;

FIG. 5 is a flow chart showing the process of measuring a standing wave ratio of a transmission antenna using a test mode of a test terminal;

FIG. 6 is a flow chart showing the process of measuring a standing wave ratio of a transmission antenna using an attenuation unit and a test call or and a test mode of a test terminal;

FIG. 7 is a flow chart showing the process of measuring a standing wave ratio of a reception antenna using a test call;

FIG. 8 is a flow chart showing the process of measuring a standing wave ratio of a reception antenna using a test mode of a test terminal;

FIG. 9 is a flow chart showing the process of measuring a standing wave ratio of a reception antenna using an attenuation unit and a test call or a test mode of

a test terminal; and

FIG. 10 is a flow chart showing the process of compensating transmission output.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

As shown in FIGs. 1 and 2, the base station according to the present invention includes one transmission terminal (TX) 100A, and two reception terminals (RX1 and RX2) 100B and 100C in accordance with diversity structure. That is, it will be understood that whereas the method for measuring the VSWR according to the present invention is described with reference to a base station of an omni-cell system as an example, it is equally applicable to sector cell systems which divide the base station into an αcell, a βcell and a γcell.

As illustrated in FIGs. 1 and 2, the transmission terminal 100A and the reception terminals 100B and 100c respectively comprise a transceiver (XCVR) 110, a directional coupler (D/C) 120 and antennas (Ant0, Ant1, and Ant2). The transceiver 110 is controlled by and commonly connected to a BCP (BTS [base station transceiver subsystem] control processor) which acts as a processor for controlling the base station system. In addition, MAP 310 and CCP 320 are also connected to the BCP 300, the MAP (maintenance administration personal computer) 310 is a personal computer for testing, maintaining, administering, and operating the base station as the base station local, and the CCP (call control processor) 320 is a processor for performing call processing while being at the BSC (base station controller), as an upper processor of the BCP 300. Furthermore, the base station test unit BTU 200 as a characteristic unit of the present invention is connected to the BCP 300, which measures the VSWR in accordance with the present invention.

The BTU 200 has, at least, a transmission path/reception path switch unit (radio frequency switch unit : RF S/W)

210, a test terminal (TM: terminal mobile station) 230, a control circuit unit (BCIU: BTU control processor) 250 and a transmission power detection unit (TPDU: Tx power detection unit) 270. In this case as shown in FIG. 1, the BTU 200 is composed only of the various units mentioned above. However, as shown in FIG. 2, the BTU 200 may further include an attenuation unit (ATTU) 290 in addition to those already mentioned. This means that the method for measuring the VSWR according to the present invention can be performed by the attenuation unit 290 on the one hand or with no usage of the attenuation unit 290 on the other hand. A description of the components mentioned above will now be given with reference to FIG. 3. A BSM (base station manager) 330 not explained, performs testing, operation, maintenance and administration for the base station and can be embodied in a work station computer.

FIG. 3 is a detailed block diagram showing the construction of a base station test unit for testing the base stations illustrated in FIGs. 1 and 2, which includes the attenuation unit 290 in the BTU 220. It is noted that the base station test unit is disclosed in Korean Patent Application No. 94-30254, entitled "Cellular Base Station Testing Device".

As shown in FIG. 3, the transmission path switch unit 210A is switched in response to the receipt of a transmission path switch control signal applied from the BCIU 250, selects a signal of a forward combining terminal (FWD) or a reflect combining terminal (RFL) of a transmission directional coupler (TX DC) and transmits the selected signal under the direction of the BTU 200. The reception path switch units 210B and 210C are switched in response to the receipt of first and second reception path switch control signals and transmit the received signals to directional couplers RX DC1 and RX DC2.

At this moment, each of the path switch units has the path switching construction corresponding to each sector

(αsector, βsector and γsector) if the base station is installed at the sector-cell. Namely, when the base station is installed at the sector-cell, each of switches (RSWA) 211 to 213 of the transmission path switch unit 210A is connected between a respective directional coupler of αsector, βsector and γsector and a combiner 221. Unlike this, each of switches (RSWB) 214 to 216 of the first reception path switch unit 210B is connected between a splitter 222 and the respective directional couplers of αsector, βsector and γsector and each of switches (RSWC) 217 to 219 of the second reception path switch unit 210C is connected between a splitter 223 and the respective directional couplers of αsector, βsector and γsector. The splitters 222 and 223 can be replaced with a 4-way splitter.

The attenuation unit 290 has a variable attenuator 291 for attenuating the transmission signal of the radio unit of the base station received from the transmission path switch unit 210A in response to a transmission attenuation control signal applied from the BCIU 250 and outputting the attenuated signal. A fixed attenuator 293 attenuates a received radio signal RF by a preset amount, outputs the attenuated signal and thus facilitates the level connection of the radio signal. A variable attenuator 294 attenuates the output of the fixed attenuator 293 in response to a reception attenuation control signal applied from the BCIU 250 and outputs the attenuated signal. A duplexer 292 separates a radio signal of the transmission path and a radio signal of the reception path and is connected between the variable attenuator 291, the fixed attenuator 293 and a test terminal 230 and exchanges the separated signals with the test terminal 230. A splitter 295 splits the signal output from the output terminal of the variable attenuator 294 into first and second reception path switch units 210B and 210C and outputting the split signals. The variable attenuators 291 and 294 have an overall 60dB attenuation range with maximum 1dB step and the splitter

can be a 2-way splitter.

The control circuit unit (BCIU: BTU control processor) 250 as a component for controlling overall operation of the BTU 200, outputs a transmission path switch control signal, first and second reception path switch control signals, transmission/reception attenuation control signals and a test control signal. The control signals are applied to the transmission path switch unit 210A, the reception path switch units 220B and 220C, the variable attenuators 291 and 294 and the test terminal 230, so that the radio path for testing has the construction similar to the real propagation environment. Also, the BCIU 250 analyses the received data and outputs data relating to the test result to the upper processor (BCP) 300.

The test terminal (TM) 230 outputs the call which is used for testing in response to the test control signal applied from the BCIU 250 ("test call") and outputs the data corresponding to the received signal to the BCIU 250. The test terminal 230 performs the functions of testing, diagnosing and monitoring the base station. A portable radio telephone (for example, an SCH-100 hand phone manufactured by the Samsung Electronics Co. Ltd.) is used as the test terminal 230.

FIGs. 4 and 10 are flow charts showing processes for measuring the VSWR by connecting the base station test unit BTU 200 to the base station having the construction as shown in FIGs. 1 to 3. The methods of measuring the VSWR according to the present invention can be divided into methods of measuring the VSWR for the transmission antenna (as illustrated in FIGs. 4 to 6) and method of measuring the VSWR for the reception antenna (as illustrated in FIGs. 7 to 9). Each of these methods can be performed using the construction of FIG. 2 or FIG. 1. In other words, the methods for measuring the VSWR for the transmission antenna and for the reception antenna will be explained, divided into method using the attenuation unit 290 and methods

using no attenuation unit. Herein, the non-usage of the attenuation unit 290 means that the VSWR for the transmission antenna and for the reception antenna are measured with a fixedly calibrated attenuation value and the usage of the attenuation unit 290 means that the VSWR for the transmission antenna and the reception antenna are measured while the attenuation value is varied.

Upon measuring the VSWR, the present invention utilizes the test terminal (TM) 230 included in the base station. The test terminal 230 may itself initiate the test signal or may simply relay a test signal received from outside. When measuring the VSWR by using the latter type of test terminal, the test terminal 230 receives the input of a given test signal applied from the exterior and generates a test call for the measurement of the VSWR. On the other hand, when measuring the VSWR using the former type of test terminal, the test terminal 230 changes the mode into the test mode in response to the input of the requirement for measuring the VSWR from the exterior and generates the test signal.

Firstly, referring to FIGs. 4 to 6, the method of measuring the VSWR for the transmission antenna will be described. FIG. 4 is a flow chart showing the process for measuring a standing wave ratio of the transmission antenna using a test call, which is performed by the construction as depicted in FIG. 1. That is, the flow chart as shown in FIG. 4 is for the case when the VSWR for the transmission antenna is measured without using the attenuation unit 290.

At step 401 of FIG. 4, the BCP 300 controls the BCIU 250 of the base station test unit (BTU) 200 and enables the transmission path switch control signal for selection of the given radio frequency (RF) signal to be generated, thus to output the generated transmission path switch control signal to one of switch units 211 to 213 of the radio frequency switch unit (RF S/W) 201A. Thus, the reflect path of the sector for measurement in response to the

transmission path switch control signal is selected. When the transmission path is selected, the BCP 300 controls the test terminal (TM) 230 and sets up the test call with the corresponding frequency at step 402. Then, the BCP 300 measures the RSSI (received signal strength indicator) using the test terminal 230 at step 403. From this, the RSSI of the reflect path for the transmission antenna is detected.

At step 404, the BCP 300 controls the BCIU 250 and generates the transmission path switch control signal, so that the forward path of the sector for measurement by the generated transmission path switch control signal can be selected. When the transmission path as mentioned before is selected, the BCP 300 detects the RSSI (forward RSSI) for the forward path of the transmission antenna with using the test terminal 230 at step 405.

After the RSSIs for the reflect path and the forward path are detected as stated before, the BCP 300 obtains the difference (forward RSSI - reflect RSSI) of two RSSIs at step 406. At this case, the value obtained corresponds to the return loss. At step 407, the BCP 300 calculates the VSWR in conformity with the relationship as shown in following expression 1 using the return loss value obtained as indicated above. After obtaining the VSWR, the BCP 300 ends the operation of obtaining the VSWR for the transmission antenna by releasing the test call at step 408.

[Expression 1]

$$Return\,Loss = 20 \log |\Gamma|$$

$$\Gamma = \frac{VSWR - 1}{VSWR + 1}$$

FIG. 5 is a flow chart showing the process of measuring the

standing wave ratio of a transmission antenna using a test mode of a test terminal, which is performed by the construction as depicted in FIG. 1. That is, the flow chart shown in FIG. 5 represents the case when the VSWR for the transmission antenna is measured with the fixed frequency value by the test terminal 230, without using the attenuation unit 290. Here, the test terminal 230 has the capacity to originate the test call.

At step 501 of FIG. 5, the BCP 300 controls the BCIU 250 of the base station test unit (BTU) 200 and enables the transmission path switch control signal for selection of the given radio frequency (RF) signal to be generated, thus outputting the generated transmission path switch control signal to one of switch units 211 to 213 of the radio frequency switch unit (RF S/W) 201A. Thus, the reflect path of the sector for measurement in response to the transmission path switch control signal is selected. When the transmission path is selected, the BCP 300 changes the test terminal (TM) 230 into the test mode and sets the frequency to be tuned to the frequency for measurement at step 502. Hereinafter, the BCP 300 measures the RSSI (received signal strength indicator) using the test terminal 230 at step 503. From this, the RSSI of the reflect path for the transmission antenna is detected.

At step 504, the BCP 300 controls the BCIU 250 and generates the transmission path switch control signal, so that the forward path of the sector for measurement by the generated transmission path switch control signal can be selected. When the transmission path as mentioned before is selected, the BCP 300 detects the RSSI (forward RSSI) for the forward path of the transmission antenna using the test terminal 230 at step 505.

After the RSSIs for the reflect path and the forward path are detected as stated before, the BCP 300 obtains the difference (forward RSSI - reflect RSSI) of the two RSSIs at step 506. The value obtained corresponds to the return

loss. At step 507, the BCP 300 calculates the VSWR in conformity with the relationship as shown in expression 1 using the return loss valued obtained as indicated above. Following obtaining the VSWR, the BCP 300 ends the operation of obtaining the VSWR for the transmission antenna by releasing the test call at step 508.

FIG. 6 is a flow chart showing the process of measuring a standing wave ratio of a transmission antenna using a test call or an attenuation unit and a test mode of a test terminal, which is performed by the construction as depicted in FIG. 2. That is, the flow chart as shown in FIG. 6 represents the case that the VSWR for the transmission antenna is measured with a variable attenuation value.

At step 601 of FIG. 6, the BCP 300 controls the BCIU 250 of the base station test unit (BTU) 200 and enables the transmission path switch control signal for selection of the given radio frequency (RF) signal to be generated, thus to output the generated transmission path switch control signal to one of switch units 211 to 213 of the radio frequency switch unit (RF S/W) 201A. Thus, the reflect path of the sector for measurement in response to the transmission path switch control signal is selected. When the transmission path is selected, the BCP 300 changes the test terminal (TM) 230 into the test mode, sets the frequency to be tuned to the frequency for measurement (or sets up the test call with the corresponding frequency) and sets the attenuation value of the variable attenuator 291 of the attenuation unit 290 to "0" at step 602. Then, the BCP 300 measures the RSSI (received signal strength indicator) using the test terminal 230 at step 603. From this, the RSSI of the reflect path for the transmission antenna is detected.

At step 604, the BCP 300 controls the BCIU 250 and generates the transmission path switch control signal, so that the forward path of the sector for measurement by the

transmission path switch control signal can be selected. When the transmission path as mentioned before is selected, the BCP 300 detects the RSSI (forward RSSI) for the forward path of the transmission antenna using the test terminal 230 at step 605.

After the RSSIs for the reflect path and the forward path are detected as stated before, the BCP 300 controls the variable attenuator 291 of the attenuation unit 290 so as to make the two RSSIs detected in steps 603 and 605 equal to each other at step 606. Namely, the BCP 300 generates the variable attenuation control signal and adjusts the difference of the two RSSIs (forward RSSI - reflect RSSI) to zero. At this case, the adjusted attenuation value corresponds to the return loss. At step 607, the BCP 300 calculates the VSWR in conformity with the relationship as shown in expression 1 using the return loss valued obtained as indicated above. Following obtaining the VSWR, the BCP 300 ends the operation of obtaining the VSWR for the transmission antenna by releasing the test mode (or the test call) at step 608.

Next, referring to FIGs. 7 to 9, the method for measuring the VSWR for the reception antenna will be described. FIG. 7 is a flow chart showing the process of measuring a standing wave ratio of a reception antenna using a test call, which is performed by the construction as depicted in FIG. 1. That is, the flow chart as shown in FIG. 7 represents the case when the VSWR for the reception antenna is measured without using the attenuation unit 290.

At step 701 of FIG. 7, the BCP 300 controls the BCIU 250 of the base station test unit (BTU) 200 and enables the reception path switch control signal for selection of the given radio frequency (RF) signal to be generated, thus to output the reception path switch control signal to one of switch units 214 to 219 of the radio frequency switch units (RF S/W) 201B and 201C. Thus, the reflect path of the sector for measurement in response to the reception path

switch control signal is selected. When the transmission path is selected, the BCP 300 disables the closed loop power control of the test terminal (TM) 230, controls the test terminal (TM) 300 and sets up the test call with the corresponding frequency at step 702. Hereinafter, the BCP 300 measures the RSSI (received signal strength indicator) using the transceiver (XCVR) 110 at step 703. From this, the RSSI of the reflect path for the reception antenna is detected.

At step 704, the BCP 300 controls the BCIU 250 and generates the reception path switch control signal, so that the forward path of the sector for measurement by the reception path switch control signal can be selected. When the transmission path as mentioned before is selected, the BCP 300 detects the RSSI (forward RSSI) for the forward path of the reception antenna using the XCVR 110 at step 705.

After the RSSIs for the reflect path and the forward path are detected as stated before, the BCP 300 obtains the difference (forward RSSI - reflect RSSI) of the two RSSIs at step 706. The value obtained corresponds to the return loss. At step 707, the BCP 300 calculates the VSWR in conformity with the relationship as shown in expression 1 using the return loss valued obtained as indicated above. After obtaining the VSWR, the BCP 300 ends the operation of obtaining the VSWR for the reception antenna by releasing the test call and enabling the closed loop power control function of the test terminal 230 at step 708.

FIG. 8 is a flow chart showing the process of measuring a standing wave ratio of a reception antenna using a test mode of a test terminal, which is performed by the construction as depicted in FIG. 1. That is, the flow chart as shown in FIG. 8 represents the case when the VSWR for the reception antenna is measured without using the attenuation unit 290.

At step 801 of FIG. 8, the BCP 300 controls the BCIU 250 of the base station test unit (BTU) 200 and enables the reception path switch control signal for selection of the given radio frequency (RF) signal to be generated, thus outputting the reception path switch control signal to one of switch units 214 to 219 of the radio frequency switch units (RF S/W) 201B and 201C. Thus, the reflect path of the sector for measurement in response to the reception path switch control signal is selected. When the transmission path is selected, the BCP 300 sets the test terminal (TM) 230 to the test mode to generate the given output of the test terminal 230 at step 802 and measures the RSSI value using the XVCR 110 at step 803. From this, the RSSI of the reflect path for the reception antenna is detected.

At step 804, the BCP 300 controls the BCIU 250 and generates the reception path switch control signal, so that the forward path of the sector for measurement by the reception path switch control signal can be selected. When the transmission path as mentioned before is selected, the BCP 300 detects the RSSI (forward RSSI) for the forward path of the reception antenna with using the XCVR 110 at step 805.

After the RSSIs for the reflect path and the forward path are detected as stated before, the BCP 300 obtains the difference (forward RSSI - reflect RSSI) of two RSSIs generated at the above steps 803 and 805 at step 806. In this case, the value obtained corresponds to the return loss. At step 807, the BCP 300 calculates the VSWR in conformity with the relationship as shown in expression 1 with using the return loss valued obtained as indicated above. After obtaining the VSWR, the BCP 300 ends the operation of obtaining the VSWR for the reception antenna by releasing the test mode at step 808.

FIG. 9 is a flow chart showing the process of measuring a standing wave ratio of a reception antenna using a test call or an attenuation unit and a test mode of a test

terminal, which is performed by the construction as depicted in FIG. 2. That is, the flow chart as shown in FIG. 9 represents the case that the VSWR for the reception antenna is measured while varying the attenuation value of the attenuation unit 290.

At step 901 of FIG. 9, the BCP 300 controls the BCIU 250 of the base station test unit (BTU) 200 and enables the reception path switch control signal for selection of the given radio frequency (RF) signal to be generated, thus to output the generated reception path switch control signal to one of switch units 214 to 219 of the radio frequency switch units (RF S/W) 201B and 201C. Thus, the reflect path of the sector for measurement in response to the generated reception path switch control signal is selected. When the transmission path is selected, the BCP 300 sets the test terminal (TM) 230 to the test mode (or sets up the test call) so as to generate the given output of the test terminal 230 at step 902 and measures the RSSI value using the XCVR 110 at step 903. From this, the RSSI (reflect RSSI) of the reflect path for the reception antenna is detected.

At step 904, the BCP 300 controls the BCIU 250 and generates the reception path switch control signal, so that the forward path of the sector for measurement by the reception path switch control signal can be selected. When the transmission path as mentioned before is selected, the BCP 300 detects the RSSI (forward RSSI) for the forward path of the reception antenna using the XCVR 110 at step 905.

After the RSSIs for the reflect path and the forward path are detected as stated before, the BCP 300 controls the variable attenuator 291 of the attenuation unit 290 so as to make the two RSSIs detected at steps 903 and 905 equal to each other at step 906. Namely, the BCP 300 generates the variable attenuation control signal and adjusts the difference of the two RSSIs (forward RSSI - reflect RSSI)

to zero. Thus, the adjusted attenuation value corresponds to the return loss. At step 907, the BCP 300 calculates the VSWR in conformity with the relationship as shown in expression 1 using the return loss valued obtained as indicated above. Following obtaining the VSWR, the BCP 300 ends the operation of obtaining the VSWR for the reception antenna by releasing the test mode (or the test call) at step 908.

FIG. 10 is a flow chart showing the process of compensating transmission output. At step 1001 of FIG. 10, the BCP 300 controls the BTU 200 and selects the forward path of the sector for measurement by the radio frequency switch unit (RF S/W) 210 for selection of the radio signal. At step 1002, the BCP 300 checks whether or not the call set up at the frequency of the selected sector exists and, when the call set up at the frequency of the selected sector does not exist, tunes to the transmission frequency of the base station using the TPDU 270 of the BTU 200. After that, the BCP 300 measures the transmission output of the base station at step 1004.

At step 1005, if the call set up at the frequency of the selected sector existed, the BCP 300 does not compensate the transmission output. Otherwise, when the call set up at the frequency of the selected sector did not exist, the BCP 300 starts with compensation of the transmission output. At step 1006, the BCP 300 calculates the transmission output of the current base station, compares the calculated value with the measured transmission output level and compensates the transmission output by as much as the compared difference.

As is apparent from the foregoing, the present invention can obtain the VSWRs for transmission and reception antennas by measuring the RSSI of the reflect signal and the RSSI of the forward sinal, without using a separate test unit, after generating the test signal using the test terminal included in the base station. Using the VSWR value

obtained as described above, it is advantageous that the existence of an abnormal state of the base station and damage to the base station can be exactly monitored and diagnosed.

CLAIMS

1. A method of measuring a standing wave ratio for an antenna in a base station of a mobile communication system comprising:

transmitting a test signal to the antenna;

during transmission of the test signal, measuring the strength of a forward signal and the strength of a reflect signal for the antenna; and

calculating the standing wave ratio for the antenna from the measured strength of the forward signal and the measured strength of the reflect signal.

2. A method of measuring a standing wave ratio according to claim 1 in which the standing wave ratio is calculated from the difference between the strength of the forward signal and the strength of the reflect signal.

3. A method of measuring a standing wave ratio for an antenna in a base station of a mobile communication system comprising:

transmitting a test signal to the antenna;

during transmission of the test signal, adjusting the attenuation value of a variable attenuator so as to cause the strength of a forward signal and the strength of a reflect signal for the antenna to take on a predetermined relationship; and

calculating the standing wave ratio for the antenna from the adjusted attenuation value.

4. A method of measuring a standing wave ratio according to claim 3 in which the predetermined relationship is equality.

5. A method of measuring a standing wave ratio according to any preceding claim in which the antenna is a transmission antenna.

6. A method of measuring a standing wave ratio according

to any one of claims 1-4 in which the antenna is a reception antenna.

7. A method of measuring a standing wave ratio according to any preceding claim in which the test signal is generated by a test terminal included within the base station.

8. A method of measuring a standing wave ratio according to claim 7 in which the test signal is generated by relaying an external test call received by the test terminal, in response to a requirement for measurement of the standing wave ratio.

9. A method of measuring a standing wave ratio according to claim 7 in which the test signal is originated by the test terminal, which enters a test mode in response to a requirement for measurement of the standing wave ratio.

10. A method of measuring a standing wave ratio according to any one of claims 7-9 in which a closed loop power control function of the test terminal is disabled.

11. A method of measuring a standing wave ratio for an antenna in a base station of a mobile communication system, the method being substantially as described with reference to and/or as illustrated in any one of FIGs. 4-10 of the accompanying drawings.

The Patent Office

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Claims searched: 1 - 11

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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G1U (UR2706, UR2728)

Int Cl (Ed.6): G01R 27/06, 27/28

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
PX	WO 97/26544 A1	(ALLGON) (publication date: 24.07.97) see fig.1 and page 1, lines 5 - 26	1 at least
X	WO 93/01503 A1	(TELENOKIA) see fig.1 and page 1, lines 4 - 23	1 at least
X	US 5157338	(J M MOTHERSBAUGH) see col.1, lines 5 - 12 and col.2, line 55 to col.3, line 8	1 and 3 at least
X	US 4110685	(V G LEENERTS) see fig.1	1 at least

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